Use of a Circulation Model to Enhance Predictability of Bioluminescence in the Coastal Ocean

Igor Shulman
College of Marine Sciences
The University of Southern Mississippi
Mail Code USM COAM
Stennis Space Center, MS 39529
phone: (228) 688-3403 fax: (228) 688-7072; e-mail: shulman@coam.usm.edu

Grant Number: N00014-02-1-0852
http://www.coam.usm.edu/ICON

LONG-TERM GOALS

The long-term objective is to contribute to the development of the components of limited area, open boundary, coastal nowcast/forecast systems that will resolve the time and length scales of the relevant ocean dynamics in shallow coastal environments.

OBJECTIVES

Our objective is to develop the technology and methodology to optimize limited spatial and temporal bioluminescence (BL) sampling for maximum impact on short-term (2-3 days) BL forecasts.

APPROACH

The BL forecasts will be conducted by assimilating limited BL observations into an advective-diffusive tracer model with the velocities and diffusivities from a nested, data-assimilating coastal circulation model of the Monterey Bay area (named the ICON model due to NOPP sponsored project "Innovative Coastal-Ocean Observing Network" (ICON)) and with a finer-resolution sub model of the ICON model (frsICON) around the upwelling front at the north of the Monterey Bay (Shulman et al., 2002a, Shulman et al., 2002b). Data sets to be used include ongoing observational efforts by Dr. Haddock in Monterey Bay, as well as the AOSN-II experiment planned for August 2003. A significant enhancement to the hydrodynamic model will be the inclusion of tidal forcing.

Modeling activities will be undertaken in conjunction with the high-resolution bioluminescence observational program being conducted by Dr. Haddock in the Monterey Bay area. During each of the three oceanographic seasons typical in this area, Dr. Haddock will use AUVs to measure BL along 5 radial sections covering the Bay over 6 subsequent days (one section will be sampled twice). These observations will be made during three typical oceanographic seasons through two full sets of seasonal cycles. A planned AUV upgrade will provide velocity data, as well as the temperature, salinity, and BL data. This coincident sampling of the BL and physical variables will allow crucial testing of our techniques, which would not be possible without data sets collected on comparable spatial and temporal scales.

Research is being performed in collaboration with Drs. D. McGillicuddy of WHOI; S. Haddock of MBARI; J.Paduan and L.Rosenfeld of NPS; and Dr. J. Kindle's group at NRL.

WORK COMPLETED and **RESULTS**

This is a new effort begun in July of 2002.

We are in the process of: 1) analyzing atmospheric and hydrodynamic conditions during the first MBARI cruise in August of 2002; and 2) acquiring necessary input data for the circulation model runs during the period of the first cruise.

The proposed research is a part of the ONR "Autonomous Ocean Sampling Network" (AOSN-II) adaptive sampling study in the Monterey Bay. We have been participating in the development of the objectives as well as in the design and planning of the AOSN II experiment.The ICON model outputs were provided to the AOSN II group.

IMPACT/APPLICATIONS

Prediction of the bioluminescence potential is critical for numerous naval operations, including preventing detection of covert operations involving submarines, Swimmer Delivery Vehicles and AUVs, and – conversely - in aiding detection of enemy incursions. In most cases, only limited *in situ* sampling of BL is possible immediately prior to, or during, these activities. The proposed research will provide technology and recommendations for optimizing this sampling and for use of these limited BL observations for short-term BL forecasts by tracers with the use of circulation model predictions.

TRANSITIONS

ICON model output will be used by the AOSN II group for testing optimal sampling schemes and for optimizing the trajectories and control theory used for AUVs.

RELATED PROJECTS

ONR, "Autonomous Ocean Sampling Network II (AOSN II) Experiment".
Coordination with a joint effort by the Harvard, MBARI, WHOI, NPS, Princeton, CalTech, JPL, NRL, and USM groups in designing and building an Adaptive Coupled Observation/Modeling Prediction System in the Monterey Bay.

ONR, "High-Resolution Measurements of Coastal Bioluminescence; Improving Short-Term Predictability Across Seasons", MBARI.
Modeling activities will be undertaken in conjunction with the high-resolution bioluminescence observational program being conducted by Dr. Haddock in the Monterey Bay area.

NRL, "Coupled Biophysical-Dynamics Across the Littoral Transition (CoBALT)."
CoBALT Pacific West Coast model predictions and COAMPS products are used for open-boundary and surface forcing in the Monterey Bay area models (ICON and frsICON models).

REFERENCES

Shulman, I., C.-R. Wu, J.K. Lewis, J.D. Paduan, L.K. Rosenfeld, J.C. Kindle, S.R. Ramp, C.A. Collins, 2002a. High Resolution Modeling and Data Assimilation in the Monterey Bay Area. Continental Shelf Research, **22**, 1129-1151.

.

Shulman, I., S.H.D. Haddock, D.J. McGillicuddy, J.D. Paduan, and W.P. Bissett, 2002c: Numerical Modeling of Bioluminescence Distributions in the Coastal Ocean. Submitted to the Journal of Atmospheric and Oceanic Technology.